

# Parfocal wide field near infrared grism design and fabrication for WFIRST

Completed Technology Project (2013 - 2014)



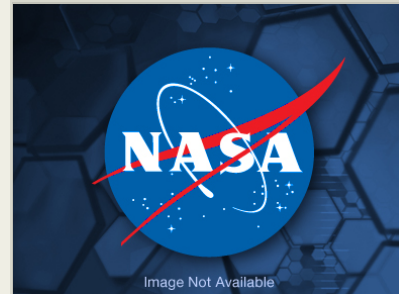
## Project Introduction

WFIRST will have Hubble image quality with 100x the field area of HST/WFC3. It requires both imaging and, working in the same optical train, a grism allowing slitless spectroscopy of 10,000's of objects across the same large field of view. The targeted outcomes from this IRAD are the mature optical and mechanical housing designs of the parfocal [same focal position as the filters held in the same element wheel] grism [a grism is a combination prism plus diffraction grating that sends a spectrum to what is otherwise an imaging focal plane] assembly, specifications of optical components, fabrication approach, and tolerances. The fabrication feasibility will be verified by a funded design study from selected vendors. If feasible, the element design and fabrication procedure will be developed by the vendors.

The original objective was to ensure that the grism assembly can be designed and fabricated to meet the WFIRST spectrometer requirements. The current grism design includes an innovative Variable Space Grating (VSG) that borrowed a concept from Computer Generated Hologram, plus spectral filter and prism. From optical design point of view, this IRAD will study how much we can further simplify the grism design without compromising the scientific objectives. We'll make every effort to search for all state of art optical fabrication techniques and to design the optics that uses the most suitable technologies. This is one way to raise TRL level. On the other hand, we'll fund the potential vendors to study and design the element(s) to our specification. We will interact with them and leverage their expertise to raise the TRL. Meanwhile, we'll encourage them to develop new fabrication methods to improve the quality and to reduce the cost. We would like to eliminate the complicated Zernike Sag Surface (ZSS), a surface that could provide any surface figure we need to compensate aberrations, from the current design. But we cannot rule it out yet until we have a solid design without ZSS. Therefore, we will fund a potential vendor in this IRAD to study ZSS fabrication. If the funding permits, we will ask the potential vendors to make small scale samples and test them at GSFC. The goal of this IRAD is to achieve TRL 4; the current TRL is roughly TRL 3.

During the course of this IRAD, it is discovered that a diffractive lens is a much better way to compensate the wavelength dependent aberration created by a grating in non-collimated space. Besides the much improved image quality, the corss due to unwanted diffraction orders can be spread as an uniform background by skillfully designing the diffractive lens and VSG.

The full project includes design a buildable slitless spectrometer, analyze the design and provide tolerance data to mechanical team. The mechanical team will design a cryo assembly with multi-degrees of adjustment. The high risky samples for diffractive lens and VSG will be procured and tested. One good news to report is that grating sample delivered to us this week has a very high



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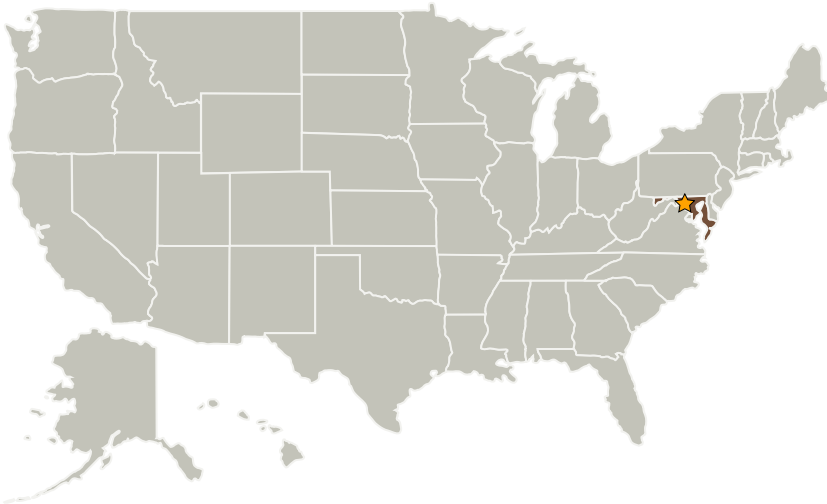


diffraction efficiency (over 90%) from today's test result, which is higher than HST's ~80% level. This is equivalent to to increase the primary mirror size by 10%. This also makes the uniform background due to unwanted grating much lower.

## Anticipated Benefits

This project is aimed to reduce the risk of NASA WFIST/AFTA mission.

## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Goddard Space Flight Center (GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

## Primary U.S. Work Locations

Maryland

## Project Website:

<http://sciences.gsfc.nasa.gov/sed/>

## Organizational Responsibility

### Responsible Mission Directorate:

Mission Support Directorate (MSD)

### Lead Center / Facility:

Goddard Space Flight Center (GSFC)

### Responsible Program:

Center Independent Research & Development: GSFC IRAD

## Project Management

### Program Manager:

Peter M Hughes

### Project Manager:

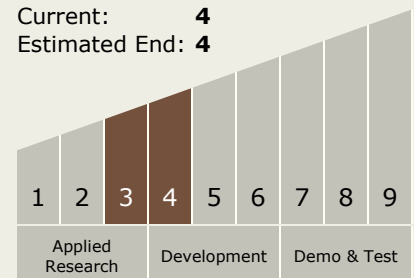
Terry Doiron

### Principal Investigator:

Qian Gong

## Technology Maturity (TRL)

Start: 3  
Current: 4  
Estimated End: 4



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## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.1 Detectors and Focal Planes